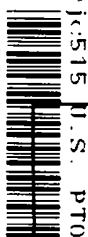


02/19/98



U.S. PTO

101-790
102-164x2
103-352x16

A

**UTILITY
PATENT APPLICATION
TRANSMITTAL**

(Only for new nonprovisional applications under 37 CFR 1.53(b))

Attorney Docket No.

862.2178

First Named Inventor or Application Identifier

TOSHIYUKI SUDO

Express Mail Label No.

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

ADDRESS TO:Assistant Commissioner for Patents
Box Patent Application
Washington, DC 202311. ☒

Fee Transmittal Form

(Submit an original, and a duplicate for fee processing)

2. ☒

Specification

Total Pages

45

3. ☒

Drawing(s) (35 USC 113)

Total Sheets

18

4. ☒

Oath or Declaration

Total Pages

2

a. ☒

Newly executed (original or copy)

b. ☐

Unexecuted for information purposes

c. ☐

Copy from a prior application (37 CFR 1.63(d))

(for continuation/divisional with Box 17 completed)

(Note Box 5 below)

i. ☐

DELETION OF INVENTOR(S)

Signed Statement attached deleting inventor(s) named in
the prior application, see 37 CFR 1.63(d)(2) and 1.33(b).5. ☐

Incorporation By Reference (useable if Box 4c is checked)

The entire disclosure of the prior application, from which a copy of the oath or
declaration is supplied under Box 4c, is considered as being part of the disclosure of
the accompanying application and is hereby incorporated by reference therein.6. ☐

Microfiche Computer Program (Appendix)

7. ☐Nucleotide and/or Amino Acid Sequence Submission
(if applicable, all necessary)a. ☐

Computer Readable Copy

b. ☐

Paper Copy (identical to computer copy)

c. ☐

Statement verifying identity of above copies

ACCOMPANYING APPLICATION PARTS8. ☒

Assignment Papers (cover sheet & document, 2 pages)

9. ☐

37 CFR 3.73(b) Statement

(when there is an assignee)

☒

Power of Attorney

10. ☐

English Translation Document (if applicable)

11. ☐Information Disclosure
Statement (IDS)/PTO-1449☐Copies of IDS
Citations12. ☐

Preliminary Amendment

13. ☒Return Receipt Postcard (MPEP 503)
(Should be specifically itemized)14. ☐Small Entity
Statement(s)☐Statement filed in prior application
Status still proper and desired15. ☐Certified Copy of Priority Document(s)
(if foreign priority is claimed)16. ☐

Other:

17. If a CONTINUING APPLICATION, check appropriate box and supply the requisite information:



Continuation



Divisional



Continuation-in-part (CIP)

of prior application No. ____/____

18. CORRESPONDENCE ADDRESS

Customer Number or Bar Code Label

(Insert Customer No. or Attach bar code label here)



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CLAIMS	(1) FOR	(2) NUMBER FILED	(3) NUMBER EXTRA	(4) RATE	(5) CALCULATIONS
	TOTAL CLAIMS <small>(37 CFR 1.16(c))</small>	36-20 -	16	X \$ 22.00 -	\$ 352.00
	INDEPENDENT CLAIMS <small>(37 cfr 1.16(b))</small>	5-3 -	2	X \$ 82.00 -	\$ 164.00
	MULTIPLE DEPENDENT CLAIMS <small>(if applicable) (37 CFR 1.16(d))</small>			\$270.00 -	\$ 0.00
				BASIC FEE <small>(37 CFR 1.16(a))</small>	\$ 790.00
			Total of above Calculations -		\$1306.00
	Reduction by 50% for filing by small entity (Note 37 CFR 1.9, 1.27, 1.28).				
	TOTAL -				\$1306.00

19. Small entity status

- a. ☐ A Small entity statement is enclosed
- b. ☐ A small entity statement was filed in the prior nonprovisional application and such status is still proper and desired.
- c. ☐ Is no longer claimed.

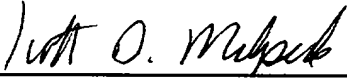
20. ☒ A check in the amount of \$ 1306.00 to cover the filing fee is enclosed.

21. ☒ A check in the amount of \$ 40.00 to cover the recordal fee is enclosed.

22. The Commissioner is hereby authorized to credit overpayments or charge the following fees to Deposit Account No. 06-1205:

- a. ☐ Fees required under 37 CFR 1.16.
- b. ☒ Fees required under 37 CFR 1.17.
- c. ☐ Fees required under 37 CFR 1.18.

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT REQUIRED

NAME	Scott D. Malpede, Reg. No. 32,533
SIGNATURE	
DATE	February 19, 1998

TITLE OF THE INVENTION
IMAGE DISPLAY SYSTEM, INFORMATION PROCESSING APPARATUS,
AND METHOD OF CONTROLLING THE SAME

5 BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

The present invention relates to a stereoscopic display apparatus which allows an observer to observe
10 a stereoscopic image by using the parallax between the right and left eyes, an information processing apparatus, a host computer for controlling the display apparatus, and a method therefor, thereby providing an operation environment for comfortable stereoscopic
15 display.

RELATED BACKGROUND ART

In general, a stereoscopic image display apparatus of the parallax barrier scheme is known well
20 as an apparatus for displaying a stereoscopic image. The parallax barrier scheme is disclosed in S. H. Kaplan, "Theory of Parallax Barriers.", J. SMPTE, Vol. 59, No. 7, pp. 11 - 21 (1952). According to this scheme, a striped image obtained by alternately
25 arranging at least right and left images of a plurality of parallax images from a plurality of

viewpoints into a vertically striped pattern is
observed through a slit pattern (called a parallax
barrier) having predetermined opening portions placed
at a predetermined distance from this image. With this
5 operation, the observer observes images corresponding
to the respective eyes with the corresponding eyes.
Japanese Patent Laid-Open Nos. 3-119889 and 5-122733
disclose stereoscopic display apparatuses in which a
parallax barrier is electronically generated by a
10 transmission type liquid crystal display device and
the like, and the shape and position of each stripe
are variably controlled to improve the compatibility
with conventional 2D image display apparatuses.

Fig. 19 shows the basic arrangement of the
15 stereoscopic image display apparatus disclosed in
Japanese Patent Laid-Open No. 3-119889. This
stereoscopic image display apparatus includes a
transmission type liquid crystal display apparatus 101
for displaying images and an electronic parallax
20 barrier 103 constituted by a transmission type liquid
crystal display placed on the liquid crystal display
apparatus 101 sandwiching a spacer 102 having a
thickness d .

The transmission type liquid crystal display
25 apparatus 101 displays a vertically striped image
consisting of parallax images sensed from two or more

directions. A parallax barrier pattern is formed at an arbitrary position on the barrier surface of the electronic parallax barrier 103 upon designation of X and Y addresses by a control means such as a microcomputer, thereby allowing a stereoscopic vision based on the principle of the above parallax barrier scheme. Note that when this electronic parallax barrier is made colorless and transparent throughout the entire image display area, a 2D image can be displayed, thus realizing the compatibility between the 2D display and 3D display.

An apparatus capable of performing mixed display of 3D and 2D images within a single frame is disclosed in Japanese Patent Laid-Open No. 5-122733. In this apparatus, as shown in Figs. 20A and 20B, a striped barrier pattern can be generated only in a partial area of the electronic parallax barrier 103.

The lenticular scheme is also known widely as a means for displaying a stereoscopic image by using the parallax between the right and left eyes of an observer as in the parallax barrier scheme. In the lenticular scheme, a lenticular lens constituted by an array of many semicylindrical lenses is placed on the front surface of a display to spatially separate an image into images for the right and left eyes, thereby allowing the observer to observe a stereoscopic image.

In the display of the lenticular scheme as well, an image displayed on the screen is a vertically striped image obtained by alternately arranging right and left images.

5 As a stereoscopic display using a horizontally striped image obtained by alternately arranging right and left images, Cyberbook (trademark) is available from Vrex Inc. In this display, as shown in Fig. 21, a striped polarizing plate 202 obtained by alternately
10 arranging two types of polarizing plates, whose polarization axis directions are perpendicular to each other, in units of horizontal lines is placed on the front surface of the liquid crystal display of a notebook personal computer 201. A displayed image is
15 observed through polarization glasses 203 having the two types of polarizing plates corresponding to those used for the striped polarizing plate 202 arranged for the right and left eyes. (In Fig. 21, the arrows indicate polarizing direction of the polarizing
20 direction of the polarizing plates.) With this arrangement, of the displayed image, lines to be seen with the right and left eyes of the observer can be separated/selected. For example, the odd lines of the liquid crystal display are used as a right-eye image
25 display lines, and the even lines are used as left-eye image display lines to allow the observer to

separately observe images formed by the respective lines with the corresponding eyes.

Various environments in which 3D displays are used can be conceived. Assume that an entire screen is occupied by a single type of image as in the case of a television set. In this case, the relative positional relationship between a displayed image and each constituent element of the apparatus always remains the same. Once, therefore, the observer sets his/her eyes at an optimal observation position, he/she can continuously obtain a proper stereoscopic vision. Assume that a plurality of windows are opened on one screen, and images are to be displayed in the respective windows like images handled in a computer. In this case, as the positions of the windows change, the relationship between each image and each constituent element of the apparatus changes. As a result, the optimal observation position changes, and hence the observer cannot always obtain a proper stereoscopic vision.

When, for example, a barrier 1 of the parallax barrier scheme and a striped image 2 displayed on the image display apparatus maintain a proper relative positional relationship, as shown in Fig. 22, light forming an image for the left eye propagates to a left eye 3, and light forming an image for the right eye

propagates to a right eye 4. As a result, the observer can properly recognize a stereoscopic image.

If, however, the relative positions of the barrier 1 and the striped image 2 displayed on the image display apparatus are shifted by one pitch in the horizontal direction with respect to the positions in Fig. 22, as shown in Fig. 23, light forming an image for the left eye propagates to the right eye 4, and light forming an image for the right eye propagates to the left eye 3. As a result, a "reversed stereoscopic vision" for the observer is produced.

When a plurality of windows are opened, and stereoscopic images are displayed in the respective windows, in particular, stereoscopic visions may be properly produced in some windows, but reversed stereoscopic visions may be produced in other windows.

When windows are opened, and images are displayed in the respective windows in this manner, since the relative positions of the barrier 1 and the striped image 2 are likely to change, the possibility of the occurrence of a reversed stereoscopic vision is high. This tendency applies to any stereoscopic display scheme, as well as the parallax barrier scheme, in which the relative positional relationship between a displayed image and other optical parts is important.

The same applies to Cyberbook available from Vrex,

which uses a "horizontally striped" parallax image as a striped image. In this case, when, for example, the relative positions of a striped polarizing plate and a striped image displayed on the image display apparatus
5 are shifted by one pitch in the vertical direction, a reversed stereoscopic vision is produced.

SUMMARY OF THE INVENTION

The present invention has been made in
10 consideration of the above problems, and has as its object to provide an image display system and an information processing apparatus which can always allow a proper stereoscopic vision by controlling the arrangement of the stripe parallax images of a
15 stereoscopic image displayed in a window to be suited to a display apparatus, and a method of controlling the system and the apparatus.

It is another object of the present invention to provide an information processing apparatus and method
20 which can always allow an observer to have a proper stereoscopic vision even with a change in the position of each window when several windows are opened on the screen, and images are displayed in the windows like images handled in a computer.

25 It is still another object of the present invention to allow a stereoscopic vision in units of

windows.

It is still another object of the present invention to always allow a proper stereoscopic vision without changing the contents displayed in a window.

5 It is still another object of the present invention to always allow a proper stereoscopic vision without changing the display position of a window.

10 It is still another object of the present invention to allow a proper stereoscopic vision while a window is moved.

According to an aspect of the present invention, in order to achieve the above objects, there is provided an image display system capable of performing stereoscopic display, comprising stereoscopic image
15 display means for displaying a stereoscopic image having stripe parallax images arranged for right and left eyes, stereoscopic vision control means for controlling directivity of the stereoscopic image such that stripe images of the stereoscopic image are
20 respectively observed with the right and left eyes, and changing means for, when a relative positional relationship between the stereoscopic image and the stereoscopic vision control means is not a proper relationship with which an observer can obtain a
25 proper stereoscopic vision, changing the relative positional relationship to realize a proper

stereoscopic vision.

According to another aspect of the present invention, there is provided an information processing apparatus which can be connected to an image display apparatus having stereoscopic vision control means for
5 controlling directivity of a stereoscopic image to allow an observer to observe stripe images of the stereoscopic image with right and left eyes of the observer, respectively, comprising generation means
10 for generating image data including a window in which stripe parallax images corresponding to the right and left eyes are arranged, determination means for determining whether a relative positional relationship between the window and the stereoscopic vision control
15 means of the image display apparatus is a proper positional relationship which allows a proper stereoscopic vision, and adjustment means for, when the determination means determines that the relationship is not the proper relationship which
20 allows a proper stereoscopic vision, adjusting the relative positional relationship to allow a proper stereoscopic vision.

According to still another aspect of the present invention, there are provided control methods for the
25 above image display system and information processing apparatus.

Other features and advantages of the present invention will be apparent from the following description taken in conjunction with the accompanying drawings, in which like reference characters designate
5 the same or similar parts throughout the figures thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are incorporated
10 in and constitute a part of the specification, illustrate embodiments of the invention and, together with the description, serve to explain the principles of the invention.

Fig. 1 is a block diagram showing the arrangement
15 of a computer system according to the first embodiment of the present invention;

Fig. 2 is a view showing an image for the left eye;

Fig. 3 is a view showing an image for the right
20 eye;

Fig. 4 is a view showing a vertically striped parallax image obtained by dividing the parallax images in Figs. 2 and 3 into vertical stripes, and alternately arranging them;

25 Fig. 5 is a view showing a horizontally striped parallax image obtained by dividing the parallax

images in Figs. 2 and 3 into horizontal stripes, and alternately arranging them;

Fig. 6 is a view showing a state in which the positions of right and left stripe images defined by a
5 directivity control means in accordance with the display position of a window for displaying a stereoscopic image coincide with the right and left stripes of the stereoscopic image;

Fig. 7 is a view showing a state in which the
10 positions of right and left stripe images defined by a directivity control means in accordance with the display position of a window for displaying a stereoscopic image do not coincide with the right and left stripes of the stereoscopic image;

Fig. 8 is a flow chart showing an operation
15 procedure performed by a host computer in the first embodiment;

Fig. 9 is a view for explaining fine adjustment
20 of a window position for a vertically striped parallax image;

Fig. 10 is a view for explaining fine adjustment
of a window position for a horizontally striped parallax image;

Fig. 11 is a flow chart showing an operation
25 procedure performed by a host computer in the second embodiment of the present invention;

Fig. 12 is a view for explaining how the contents of a displayed image in a window are changed in the second embodiment;

Fig. 13 is a view for explaining how the contents of a displayed image in a window are changed in the second embodiment;

Fig. 14 is a view for explaining how the contents of a displayed image in a window are changed in the second embodiment;

Fig. 15 is a view for explaining how the contents of a displayed image in a window are changed in the second embodiment;

Fig. 16 is a view for explaining how the contents of a displayed image in a window are changed in the second embodiment;

Fig. 17 is a flow chart showing a control procedure performed by a host computer in the third embodiment of the present invention;

Fig. 18 is a flow chart showing a control procedure for preventing a reversed stereoscopic vision during a window dragging operation in the fourth embodiment of the present invention;

Fig. 19 is a view showing the basic arrangement of the stereoscopic image display apparatus disclosed in Japanese Patent Laid-Open No. 3-119889;

Figs. 20A and 20B are views for briefly

explaining the stereoscopic image display apparatus disclosed in Japanese Patent Laid-Open No. 5-122733;

Fig. 21 is a perspective view for briefly explaining a stereoscopic image display apparatus using Cyberbook (trademark);

Fig. 22 is a view showing a state in which the relative positions of a barrier and a striped image in the parallax barrier scheme have a proper relationship; and

Fig. 23 is a view showing a state in which the relative positions of the barrier and the striped image in the parallax barrier scheme have an improper relationship.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Preferred embodiments of the present invention will now be described in detail in accordance with the accompanying drawings.

<First Embodiment>

Each of the following embodiments will exemplify a stereoscopic display apparatus for allowing an observer to observe a stereoscopic image by using the parallax between the right and left eyes and a computer system including a host computer for controlling the stereoscopic display apparatus.

Fig. 1 is a block diagram showing the arrangement

of a computer system according to the first embodiment.
Referring to Fig. 1, reference numeral 10 denotes a
host computer; 20, a stereoscopic display apparatus;
11, a CPU for realizing various types of control
5 operations performed by the host computer 10; 12, a
ROM storing a boot program, which is executed when the
CPU 11 is started, and various types of data; and 13,
a RAM which serves as a main memory for storing
control programs executed by the CPU 11 and provides a
10 work area used when the CPU 11 executes various types
of control operations. Reference numerals 14 and 15
respectively denote a keyboard and a pointing device,
which are used to input commands from the user.
Reference numeral 16 denotes an external memory such
15 as a hard disk, which is used to store various
application programs and data. Note that each
application program stored in the external memory 16
is loaded into the main memory area of the RAM 13 when
it is executed by the CPU 11. Reference numeral 17
20 denotes a display interface, which is connected to the
stereoscopic display apparatus 20 in this embodiment;
and 18, a bus for connecting the respective components
of the host computer 10 to each other.

The stereoscopic display apparatus 20 includes an
25 interface 21 for receiving a video signal and position
information indicating a stereoscopic display position

from the host computer 10. Note that the video signal and the position information are respectively supplied to drivers 22 and 23. The driver 22 controls a transmission type liquid crystal display 101 of the stereoscopic display apparatus on the basis of the input video signal to display an image corresponding to the video signal. The driver 23 controls an electronic parallax barrier 103 on the basis of the input position information to display a parallax barrier pattern in the stereoscopic display area indicated by the position information. Note that the transmission type liquid crystal display 101 and the electronic parallax barrier 103 are the same as those described with reference to Fig. 19. When the electronic parallax barrier 103 is driven, the stripes of the parallax barrier pattern are formed at fixed positions. That is, the display area for the barrier pattern is controlled in accordance with position information, but the positions at which the black stripes can be produced are fixed.

The communication unit constituted by the above interfaces 17 and 21 transmits the above video signal and position information. This communication unit may be a combination of a conventional video interface and serial interface (RS232C or the like) or a dedicated interface. In addition, the dedicated interface may

use unused connector pins of a conventional video interface.

Note that above video signal includes both a general 2D image and a 3D image allowing a stereoscopic vision (e.g., the above striped image constituted by two types of parallax images). In this embodiment, 2D and 3D images are displayed in units of windows. In addition, the above position information indicates the size and position of the area in which the above stereoscopic image is present. If, therefore, a parallax barrier pattern is displayed in the area, of the electronic parallax barrier 103, which is indicated by position information, and the image based on a video signal is displayed on the transmission type liquid crystal display 101, the 3D image contained in the video signal can be stereoscopically viewed, and the general 2D image can be properly displayed.

In this embodiment, an apparatus using the parallax barrier scheme will be mainly described. As is obvious, however, the present invention can also be applied to the Cyberbook (trademark) scheme described with reference to Fig. 21. Note that the Cyberbook scheme does not require the above position information because the host computer 10 and the stereoscopic display apparatus 20 are integrated.

In a stereoscopic display apparatus designed to allow the observer to observe a stereoscopic image by using the parallax between the right and left eyes, the images to be displayed on the image display screen are roughly classified into two types, i.e., a vertically striped parallax image and a horizontally striped parallax image. These images will be further described below. For example, Fig. 2 shows an image for the left eye; and Fig. 3, an image for the right eye. A vertically striped parallax image is obtained by dividing the images in Figs. 2 and 3 into vertical stripes, and alternately arranging and synthesizing them. A horizontally striped image is obtained by dividing the images in Figs. 2 and 3 into horizontal stripes, and alternately arranging and synthesizing them (referring to Figs. 4 and 5, reference symbols L and R denote images for the left and right eyes, respectively).

Each striped image can be divided into right and left images when combined with a directivity control means such as a barrier, a lenticular lens, or a striped polarizing plate. If, however, the directivity control means and a striped image are not set at proper relative positions, the right and left images are not observed with the corresponding eyes, as described with reference to Figs. 22 and 23. Since the

directivity control means is a component incorporated in the stereoscopic display apparatus, the position of the means is basically fixed. In general, when an image is to be handled in a computer, a window which
5 can be moved to an arbitrary position is opened, and the image is displayed in the window. For this reason, the directivity control means and the striped image may not be set at proper relative positions depending on the position of the window.

- 10 Assume that in a stereoscopic display apparatus using vertically striped parallax images, right-eye strip images (the areas indicated by "R" and surrounded with the solid lines in a window 6) are superimposed on the right-eye image display areas (the
15 areas indicated by "R" and surrounded with the dotted lines in a screen 7) of the directivity control means (coinciding with the screen 7 when viewed from the front surface side), as shown in Fig. 6. In this case, the observer can obtain a proper stereoscopic vision.
- 20 In contrast to this, assume that the window 6 for displaying an image is located at the position in Fig. 7 within the screen 7, and the right-eye strip images (the areas indicated by "R" and surrounded with the solid lines in the window 6) are superimposed on
25 the left-eye image display areas (the areas indicated by "L" and surrounded with the dotted lines in the

screen 7) of the directivity control means. In this case, the observer cannot obtain a proper stereoscopic vision, but has a reversed stereoscopic vision (the left-eye image is seen with the right eye, and the right-eye image is seen with the left eye).

To eliminate this inconvenience, in this embodiment, the following control is performed by the computer. Fig. 8 is a flow chart showing an operation procedure performed by the host computer in the first embodiment. In step S10, the host computer 10 detects that a window for stereoscopic image display is opened or its position is moved. In step S11, the host computer 10 checks the position of the window after it is opened or moved to detect whether the window is at a proper position for a stereoscopic vision. That is, if the right-eye and left-eye image display areas determined with respect to the screen 7 coincide with the display positions of the respective images in the window 6, as shown in Fig. 6, the host computer 10 determines that the window is at the proper position. If the right-eye and left-eye image display areas determined with respect to the screen 7 do not coincide with the display positions of the respective images in the window 6, as shown in Fig. 7, the host computer 10 determines that the window is at an improper position. Upon determining that the window

is at the proper position, the host computer 10
continues the display state. Otherwise, the flow
advances to step S12 to automatically perform fine
adjustment of the window position. Although not shown
5 in the flow chart, if the opened or moved window is
not for stereoscopic image display, the flow does not
advance to step S11 and the subsequent steps.

A method of detecting the generation or movement
of a window and checking its position depends on the
10 OS, the application, or the like used in the computer.
Assume that an application which operates on "Windows
3.1" (trademark), which is an OS available from
Microsoft Corporation, is to be created by using
Visual Basic Ver.2.0 (trademark), which is an
15 application development language available from
Microsoft Corporation. In this case, a window is
recognized as an object called "Form". The generation
of a window is defined as an event represented by
Form_Load(), and the movement of a window is defined
20 as an event represented by Form_Paint(). If, therefore,
a program is created such that when the execution of
each event is confirmed, a function for detecting the
position of the window (Form) is called, the current
position of the window which is moved or generated can
25 be obtained.

A method of finely adjusting the position of a

window will be described next with reference to
Figs. 9 and 10. Fig. 9 explains fine adjustment of a
window position for a vertically striped parallax
image. Fig. 10 explains fine adjustment of a window
5 position for a horizontally striped parallax image.

When a vertically striped parallax image is to be
displayed, the window is moved to the right or left by
one stripe pitch in the horizontal direction, as shown
in Fig. 9. In many cases, the period of stripe images
10 coincides with the minimum pixel pitch of an image
display surface. In this case, therefore, it suffices
if the window is moved to the right or left by one
pixel. With this operation, the reversed stereoscopic
vision state is corrected to the proper stereoscopic
15 vision state.

When a horizontally striped parallax image is to
be displayed, the window is moved up or down by one
stripe pitch in the vertical direction within the
screen, as shown in Fig. 10. In many cases, the period
20 of stripe images coincides with the minimum pixel
pitch of the image display surface. In this case,
therefore, it suffices if the window is moved up or
down by one pixel. With this operation, the reversed
stereoscopic vision state is corrected to the proper
25 stereoscopic vision state.

Assume that assignment information determined by

the relative positional relationship with the electronic parallax barrier 103 as a directivity control means and indicating the assignment of positions, on the transmission type liquid crystal display 101, where images for the right and left eyes are to be displayed are stored in the memory of the host computer 10 in advance. The determination processing in step S11 is performed on the basis of this assignment information. The assignment information may be notified from the stereoscopic display apparatus 20 by communication, or may be held in a driver program added to the stereoscopic display apparatus 20.

When a window is automatically moved in this manner, the amount of movement is very small in most cases. For this reason, such movement is hardly recognized by the observer.

As described above, according to the first embodiment, there is provided a stereoscopic display which can automatically maintain a proper stereoscopic vision without attracting observer's attention.

<Second Embodiment>

The second embodiment of the present invention will be described next. In the second embodiment as well, the present invention is applied to a stereoscopic display apparatus 20 which allows an

observer to observe a stereoscopic image by using the parallax between the right and left eyes and a computer system including a host computer 10 for controlling the display apparatus.

5 In the first embodiment, a proper stereoscopic vision state is maintained by automatically moving a window upon detection of the window position. In contrast to this, in the second embodiment, a proper stereoscopic vision is maintained by changing the
10 contents of an image to be displayed after detection of the position of a window.

Fig. 11 is a flow chart showing an operation procedure performed by the host computer in the second embodiment. In step S20, the host computer 10 detects
15 that a window for stereoscopic image display is opened or its position is moved. Opening or movement of a window is detected in the above manner. In step S21, the host computer 10 checks the position of the window to detect whether the window is at a position where a
20 proper stereoscopic vision is realized. If the window position is at a proper position, the current state is maintained. If the window position is not at a proper position, the flow advances to step S22 to automatically change the contents of a displayed image.

25 Processing of changing the contents of the displayed image in step S22 will be described in

detail next. Figs. 12 to 16 explain how the contents of the displayed image within the window are changed.

When the displayed image is a vertically striped parallax image, one of the following changing
5 operations is performed.

(1) As shown in Fig. 12, the image in the window is moved to the right by one stripe pitch in the horizontal direction within the screen. Obviously, the image in the window may be moved to the left by one
10 stripe pitch.

(2) The image is displayed upon interchange of the L and R areas.

In method (1), since the period of stripe images coincides with the minimum pixel pitch of an image
15 display screen in most cases, the image is moved to the right or left by one pixel. In this case, the position of the window is not changed, but only the image in the window is moved.

When only the displayed image filling the window
20 is moved, an area without any image data is inevitably displayed. In such a case, this area may be displayed as a solid black area, as shown in Fig. 13.

Alternatively, as shown in Fig. 14, only an area smaller than the original striped image by one stripe
25 in the horizontal direction is displayed in advance in the window, and the data in the area outside the

window, which has not been displayed, is displayed when the image needs to be moved. In the case shown in Fig. 14, the image in the window is moved to the left.

In method (2), since the left and right images of the striped image are alternately arranged, the image is displayed upon interchanging the left and right stripes.

When, for example, the left-eye image (Fig. 2) and the right-eye image (Fig. 3) are to be synthesized into a striped image, two types of images, i.e., the image in Fig. 4 and the image in Fig. 15, are generated by changing the order of right and left stripes. If, therefore, one of the images is displayed, and a reversed stereoscopic vision state occurs, a proper stereoscopic vision state can be set by interchanging one image and the other image.

When the display image is a horizontally striped parallax image, one of the following changing operations is performed.

(1) As shown in Fig. 16, the image in the window is moved by one stripe pitch in the vertical direction within the screen (up-and-down direction).

(2) The image is displayed upon interchanging the L and R areas.

Since the contents of the changing operations are the same as those in the case of the vertically

striped parallax image, a detailed description thereof will be omitted.

In most cases, the contents of such a displayed image can be automatically changed by slightly moving the image. Therefore, the observer hardly recognize this movement.

According to this embodiment as well, therefore, there is provided a stereoscopic display which can automatically maintain a proper stereoscopic vision without attracting observer's attention.

<Third Embodiment>

The third embodiment of the present invention will be described next. In the third embodiment as well, the present invention is applied to a stereoscopic display apparatus 20 which allows an observer to observe a stereoscopic image by using the parallax between the right and left eyes and a computer system including a host computer 10 for controlling the display apparatus.

In the first and second embodiments, a reversed stereoscopic vision is prevented by moving or changing a displayed image. In contrast to this, in the third embodiment, a stereoscopic vision state is maintained by changing the state of a directivity control means upon detection of the position of a window. The stereoscopic display used in the third embodiment is

therefore designed to actively change the relative positional relationship between the image display surface and the directivity control means. In the parallax barrier scheme, for example, if the barrier unit has a mechanism for allowing the unit to mechanically move while keeping parallel to the screen, such a state change can be made. Alternatively, the electronic parallax barrier may be designed to change the stripe display positions.

Fig. 17 is a flow chart showing a control procedure performed by the host computer in the third embodiment. When the host computer 10 detects in step S30 that a window is opened or moved, the flow advances to step S31. In step S31, if it is determined on the basis of the position of the window after it is opened or moved that the window is a window to be subjected to stereoscopic image display, the host computer 10 checks the position of the window after it is opened or moved, and determines whether the window is at a position where a proper stereoscopic vision is obtained. If it is determined that the window is at the proper position, the host computer 10 continues the current state. Otherwise, the flow advances to step S32 to automatically change the state of the directivity control means.

The state of this directivity control means is

changed as follows.

When the displayed image is a vertically striped parallax image, the directivity control means is moved to the right or left by one pitch of the periodic structure of the directivity control means in the horizontal direction within the screen. Note that the positions of the window and the image are not changed in this case.

When a stereoscopic display which can generate a striped barrier pattern at an arbitrary position on the display, as disclosed in Japanese Patent Laid-Open No. 5-122733, is used, since a directivity control means can be electronically generated at an arbitrary position, the above operation of changing the state of the directivity control means can be performed more easily.

As described above, in the third embodiment, the relative positional relationship between a parallax barrier and a striped parallax image is detected to automatically perform active control on the parallax barrier.

When the displayed image is a horizontally striped parallax image, the directivity control means is moved up or down by one pitch of the periodic structure of the directivity control means in the vertical direction within the screen. The contents of

this changing operation are the same as those in the case of the vertically striped parallax image.

In most cases, the contents of such a displayed image can be automatically changed by slightly moving the image. Therefore, the observer hardly recognize this movement. According to this embodiment, similar to the first and second embodiments, therefore, there is provided a stereoscopic display which can automatically maintain a proper stereoscopic vision without attracting observer's attention.

<Fourth Embodiment>

The fourth embodiment of the present invention will be described next. In the first to third embodiments, the position of a window, the contents of an image, and the state of the directivity control means are changed in accordance with the static window position. In the fourth embodiment, even when the position of a window dynamically changes, a proper stereoscopic vision state is maintained by performing the above state changing operations.

In general, when the cursor pointer of a mouse is placed on the title bar on the upper portion of a window and moved to a desired position in a clicked state, the window moves together with the cursor pointer as if the window is restrained by the movement of the mouse. An operation of moving a window together

with the cursor pointer is called dragging. An operation of releasing a window by releasing the button at a proper position after dragging is called dropping.

5 The position of a window dynamically changes in accordance with the movement of the cursor pointer while the window is dragged. This window and the image in the window may be kept displayed during this dragging operation. When, therefore, the image in the
10 window is a striped parallax image, a reversed stereoscopic vision must also be prevented during dragging of the window by some means. Fig. 18 is a flow chart showing a control procedure for preventing a reversed stereoscopic vision during dragging of a
15 window. When the start of the movement of a window by dragging is detected in step S41, it is checked in step S42 whether the current position of the window is a position where a proper stereoscopic vision can be realized. If YES in step S42, the flow advances to
20 step S44.

 If it is determined that the window is at a position where a reversed stereoscopic vision occurs, the flow advances to step S43 to execute a corresponding state changing operation. In this case,
25 the "corresponding state changing operation" indicates finely changing the window position (first embodiment),

changing the contents of the image in the window
(second embodiment), or changing the state of the
stereoscopic (third embodiment) which is described in
the corresponding embodiment.

- 5 The flow then advances to step S44 to check
whether the dragging operation is continued. If YES in
step S44, the flow returns to step S42. If NO in step
S44, this processing is terminated.

Although the basic policy of the above processing
10 does not greatly differ from that in the first to
third embodiment, it should be noted that detection of
the position of a window, verification of the window
position, and a corresponding state changing operation
are performed at very high speed. This is because, the
15 position of a window incessantly changes from proper
stereoscopic vision position to improper positions
while the window position dynamically changes owing to
dragging, and the observer cannot continuously obtain
a proper stereoscopic vision unless a corresponding
20 state changing operation is performed to prevent a
reversed stereoscopic vision every time the window
position is set at an improper position. In this
embodiment, therefore, the window detection period
during dragging is set to be very short to complete
25 verification of the window position and a
corresponding state changing operation within a period

of time shorter than the above period.

As described above, according to the fourth embodiment, there is provided a stereoscopic display which can automatically maintain a proper stereoscopic vision even while the observer is moving a window.

As described above, according to each embodiment described above, in the computer system including the stereoscopic display apparatus which allows the observer to observe a stereoscopic image by using the parallax between the right and left eyes, and the host computer for controlling the display apparatus, when several windows are opened on the screen, and stereoscopic images are displayed in the windows, the observer can always have a proper stereoscopic vision in a given window even if the position of the window changes.

In both the parallax barrier scheme and the lenticular scheme, position pixel unit width on the image display surface corresponds to the eye width of the observer. Since an image having a size of several μm is enlarged into an image having a size of several cm, a one-pitch shift of the displayed image as in the above embodiments greatly influences the optimal observation position. That is, adjustment by such a one-pitch shift is very effective.

Note that the present invention may be applied to

either a system constituted by a plurality of equipments (e.g., a host computer, an interface device, a reader, a printer, and the like), or an apparatus consisting of a single equipment (e.g., a copying machine, a facsimile apparatus, or the like).

The objects of the present invention are also achieved by supplying a storage medium, which records a program code of a software program that can realize the functions of the above-mentioned embodiments to the system or apparatus, and reading out and executing the program code stored in the storage medium by a computer (or a CPU or MPU) of the system or apparatus.

In this case, the program code itself read out from the storage medium realizes the functions of the above-mentioned embodiments, and the storage medium which stores the program code constitutes the present invention.

As the storage medium for supplying the program code, for example, a floppy disk, hard disk, optical disk, magneto-optical disk, CD-ROM, CD-R, magnetic tape, nonvolatile memory card, ROM, and the like may be used.

The functions of the above-mentioned embodiments may be realized not only by executing the readout program code by the computer but also by some or all of actual processing operations executed by an OS

(operating system) running on the computer on the basis of an instruction of the program code.

Furthermore, the functions of the above-mentioned embodiments may be realized by some or all of actual processing operations executed by a CPU or the like arranged in a function extension board or a function extension unit, which is inserted in or connected to the computer, after the program code read out from the storage medium is written in a memory of the extension board or unit.

As has been described above, according to the present invention, the position of a striped parallax image as a stereoscopic image displayed in a window can be set at a position suited to the display apparatus.

According to the present invention, therefore, when several windows are opened on the screen, and images are displayed in the windows as in the case of images handled in the computer, the observer can always have a proper stereoscopic vision in a given window even if the position of the window changes.

As many apparently widely different embodiments of the present invention can be made without departing from the spirit and scope thereof, it is to be understood that the invention is not limited to the specific embodiments thereof except as defined in the claims.

WHAT IS CLAIMED IS:

1. An image display system capable of performing stereoscopic display, comprising:

stereoscopic image display means for displaying a
5 stereoscopic image having stripe parallax images arranged for right and left eyes;

stereoscopic vision control for controlling directivity of the stereoscopic image such that stripe images of the stereoscopic image are respectively
10 observed with the right and left eyes; and

changing means for, when a relative positional relationship between the stereoscopic image and said stereoscopic vision control means is not a proper relationship with which an observer can obtain a
15 proper stereoscopic vision, changing the relative positional relationship to realize a proper stereoscopic vision.

2. The system according to claim 1, wherein said stereoscopic image display displays a stereoscopic
20 image in a window opened at a desired position within a display screen.

3. The system according to claim 2, wherein said changing means moves the window by a distance corresponding to a stripe pitch of the stripe image in
25 a direction of stripe width of the stripe image.

4. The system according to claim 3, wherein an

amount of movement of the window is equal to a minimum pixel pitch of said stereoscopic image display means.

5. The system according to claim 3, wherein the stripe image is constituted by a horizontal stripe image in the screen, and a direction in which the window is moved is a vertical direction in the screen.

6. The system according to claim 3, wherein the striped image is constituted by vertical stripe images in the screen, and a direction in which the window is moved is a horizontal direction in the screen.

7. The system according to claim 2, wherein said changing means moves the stereoscopic image in the window by a distance corresponding to length of a short side of each of the stripe images constituting the stereoscopic image in a direction parallel to a short side of the stripe image.

8. The system according to claim 7, wherein an amount of movement of the stereoscopic image in the window is equal to a minimum pixel pitch of said stereoscopic image display means.

9. The system according to claim 7, wherein the stripe image is constituted by a horizontal stripe image in the screen, and a direction in which the stereoscopic image in the window is moved is a vertical direction in the screen.

10. The system according to claim 7, wherein the

striped image is constituted by vertical stripe images in the screen, and a direction in which the stereoscopic image in the window is moved is a horizontal direction in the screen.

5 11. The system according to claim 2, wherein said changing means interchanges odd and even stripe images constituting the stereoscopic image displayed in the window.

10 12. The system according to claim 2, wherein said changing means changes a relative positional relationship between the stereoscopic image and said stereoscopic vision control means by changing said stereoscopic vision control means.

15 13. The system according to claim 12, wherein said changing means physically moves said stereoscopic vision control means.

20 14. The system according to claim 12, wherein said stereoscopic vision control means comprises optical directivity control means constituted by a spatial light modulation element which is electronically controlled, and

said changing means electronically controls said optical directivity control means to shift a state of said control means to a state in which an observer can
25 obtain a proper stereoscopic vision.

15. The system according to claim 1, wherein said

changing means is executed after the window is opened and a stereoscopic image is displayed therein or the window is moved.

16. The system according to claim 1, wherein said
5 changing means is executed at respective positions between movements of the window while the window is moved.

17. The system according to claim 16, wherein an
10 execution period of said changing means is shortened while the window is moved.

18. An information processing apparatus which can be connected to an image display apparatus having stereoscopic vision control means for controlling
15 directivity of a stereoscopic image to allow an observer to observe stripe images of the stereoscopic image with right and left eyes of the observer, respectively, comprising:

generation means for generating image data including a window in which stripe parallax images
20 corresponding to the right and left eyes are arranged;

determination means for determining whether a relative positional relationship between the window and said stereoscopic vision control means of said image display apparatus is a proper positional
25 relationship which allows a proper stereoscopic vision; and

adjustment means for, when said determination
means determines that the relationship is not the
proper relationship which allows a proper stereoscopic
vision, adjusting the relative positional relationship
5 to allow a proper stereoscopic vision.

19. The apparatus according to claim 18, wherein said
adjustment means moves the window by a distance
corresponding to length of a short side of the stripe
image in a direction parallel to a short side of the
10 stripe image.

20. The apparatus according to claim 19, wherein an
amount of movement of the window is equal to a minimum
pixel pitch of said image display apparatus connected
to said information processing apparatus.

15 21. The apparatus according to claim 19, wherein the
stripe image is constituted by a horizontal stripe
image in the screen, and a direction in which the
window is moved is a vertical direction in the screen.

22. The apparatus according to claim 19, wherein the
20 striped image is constituted by vertical stripe images
in the screen, and a direction in which the window is
moved is a horizontal direction in the screen.

23. The apparatus according to claim 18, wherein said
adjustment means moves the stereoscopic image in the
25 window by a distance corresponding to length of a
short side of each of the stripe images constituting

the stereoscopic image in a direction parallel to a short side of the stripe image.

24. The apparatus according to claim 23, wherein an amount of movement of the stereoscopic image in the window is equal to a minimum pixel pitch of said image display apparatus.

25. The apparatus according to claim 23, wherein the stripe image is constituted by a horizontal stripe image in the screen, and a direction in which the stereoscopic image in the window is moved is a vertical direction in the screen.

26. The apparatus according to claim 23, wherein the striped image is constituted by vertical stripe images in the screen, and a direction in which the stereoscopic image in the window is moved is a horizontal direction in the screen.

27. The apparatus according to claim 18, wherein said adjustment means interchanges odd and even stripe images constituting the stereoscopic image displayed in the window.

28. The apparatus according to claim 18, wherein said adjustment means changes a relative positional relationship between the stereoscopic image and said stereoscopic vision control means by changing said stereoscopic vision control means.

29. The apparatus according to claim 28, wherein said

adjustment means adjusts the relative positional relationship between the stereoscopic image and said stereoscopic vision control means by physically moving said stereoscopic vision control means.

- 5 30. The apparatus according to claim 28, wherein said adjustment means adjusts the relative positional relationship between the stereoscopic image and said stereoscopic vision control means by electronically controlling optical directivity control means included
- 10 in said stereoscopic vision control means and constituted by spatial light modulation element which is electronically controlled.

31. The apparatus according to claim 18, further comprising detection means for detecting that a window
- 15 in which a stereoscopic image is to be displayed is opened or moved, and

wherein said adjustment means is executed when said detection means detects that the window is opened or moved.

- 20 32. The apparatus according to claim 18, further comprising detection means for detecting movement of a window in which a stereoscopic image is displayed, and

wherein said adjustment means is executed at respective positions between movements of the window

25 while the window is moved.

33. The apparatus according to claim 32, wherein an

execution period of said adjustment means is shortened while the window is moved.

34. A method of controlling an information display system having stereoscopic vision control means for
5 controlling directivity of a stereoscopic image obtained by arranging stripe parallax images corresponding to right and left eyes of an observer to allow the observer to observe stripe images of the stereoscopic image with right and left eyes,
10 respectively, comprising:

the stereoscopic image display step of displaying a stereoscopic image obtained by arranging stripe parallax images corresponding to the right and left eyes;

15 the detection step of detecting a relative positional relationship between the stereoscopic image and said stereoscopic vision control means; and

the changing step of, when the relative positional relationship detected in the detection step
20 is not a proper relationship which allows a proper stereoscopic vision, changing the relative positional relationship to allow a proper stereoscopic vision.

35. A method of controlling an information processing apparatus which can be connected to an image display
25 apparatus having stereoscopic vision control means for controlling directivity of a stereoscopic image

obtained by arranging stripe parallax images
corresponding to right and left eyes of an observer to
allow the observer to observe stripe images of the
stereoscopic image with right and left eyes,

5 respectively, comprising:

the generation step of generating image data
including a window in which stripe parallax images
corresponding to the right and left eyes are arranged;

the determination step of determining whether a
10 relative positional relationship between the window
and said stereoscopic vision control means of said
image display apparatus is a proper positional
relationship which allows a proper stereoscopic
vision; and

15 the adjustment step, when it is determined in the
determination step that the relationship is not the
proper relationship which allows a proper stereoscopic
vision, adjusting the relative positional relationship
to allow a proper stereoscopic vision.

20 36. A storage medium storing a computer program for
performing image display by using an image display
apparatus having stereoscopic vision control means for
controlling directivity of a stereoscopic image
obtained by arranging stripe parallax images
25 corresponding to right and left eyes of an observer to
allow the observer to observe stripe images of the

stereoscopic image with right and left eyes,
respectively, said computer program comprising:

5 a code of the determination step of determining
whether a relative positional relationship between a
window in which stripe parallax images corresponding
to the right and left eyes are arranged and said
stereoscopic vision control means of said image
display apparatus is a proper positional relationship
which allows a proper stereoscopic vision; and

10 a code of the adjustment step of, when it is
determined in the determination step that the
relationship is not the proper relationship which
allows a proper stereoscopic vision, adjusting the
relative positional relationship to allow a proper
15 stereoscopic vision.

ABSTRACT OF THE DISCLOSURE

A stereoscopic image display apparatus for displaying a stereoscopic image, which is obtained by alternately arranging stripe parallax images R and L corresponding to the right and left eyes, in a window includes a parallax barrier for a stereoscopic vision. When the display position of a window including a stereoscopic image which is set after the window is opened or moved and the positions of the right-eye and left-eye stripes of a parallax barrier have a relationship which does not allow a proper stereoscopic vision, the display position of the window is moved by one stripe in the horizontal direction.

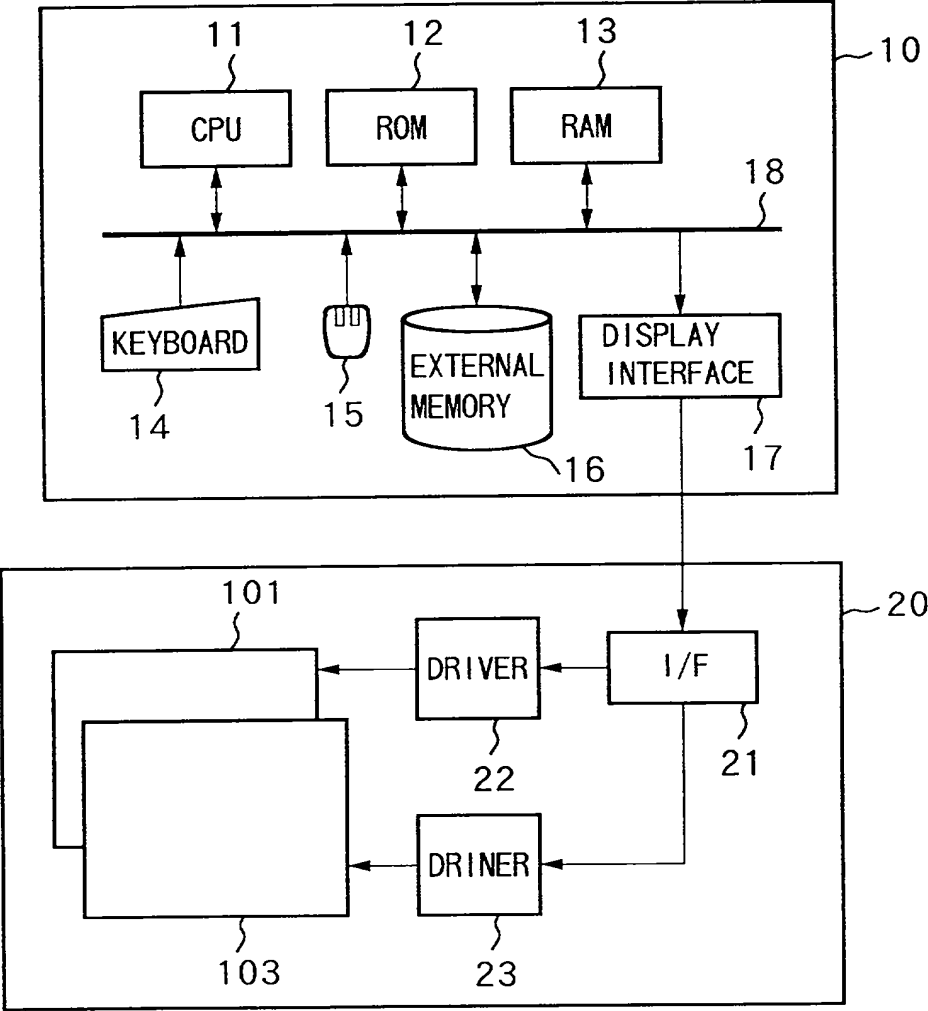
CFM1223US
C2176

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

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277 Park Avenue
New York, N.Y. 10172
Telephone No. (212)758-2400

[illegible]

FIG.1



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FIG.2

L

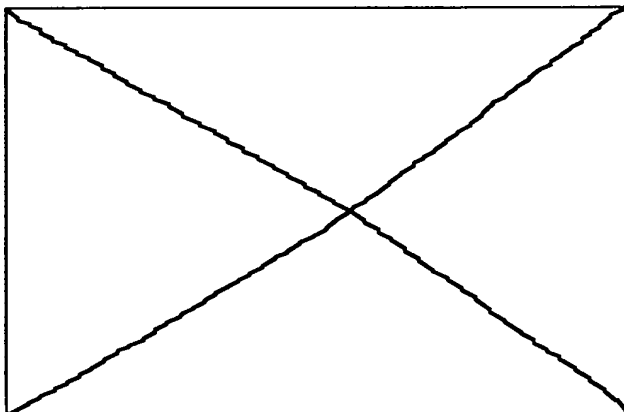
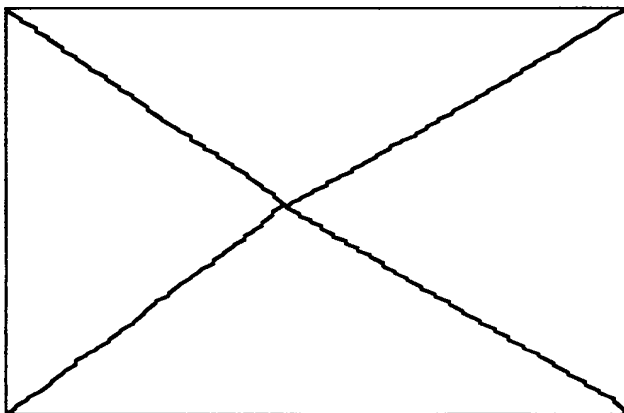


FIG. 3

R



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FIG.4

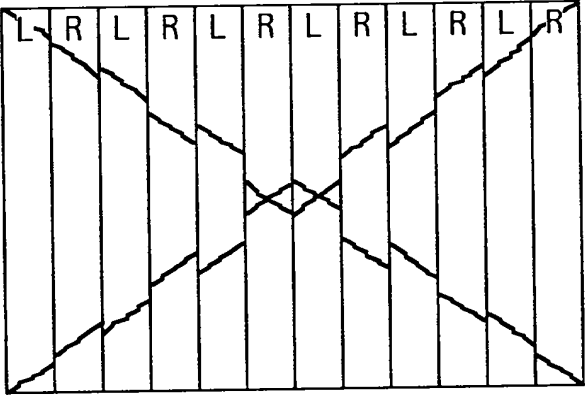
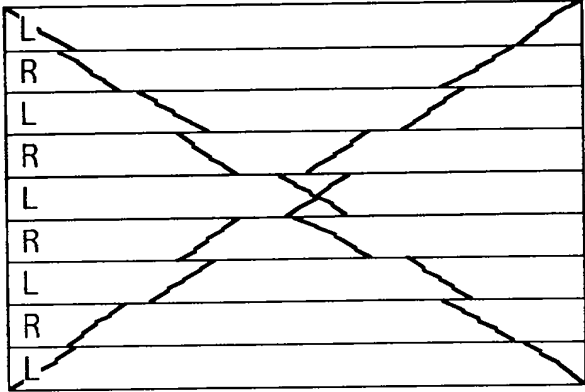


FIG.5



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FIG.6

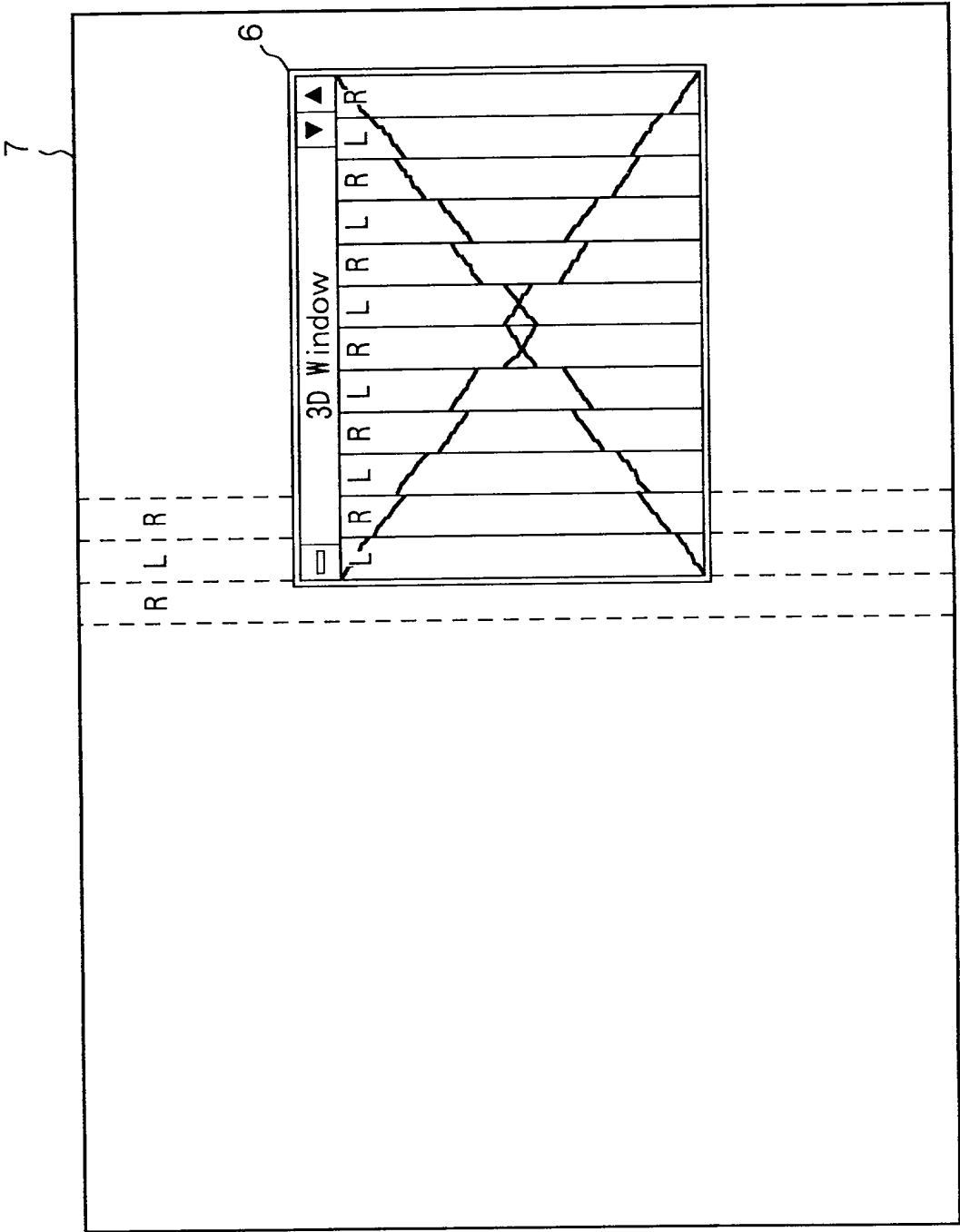


FIG. 7

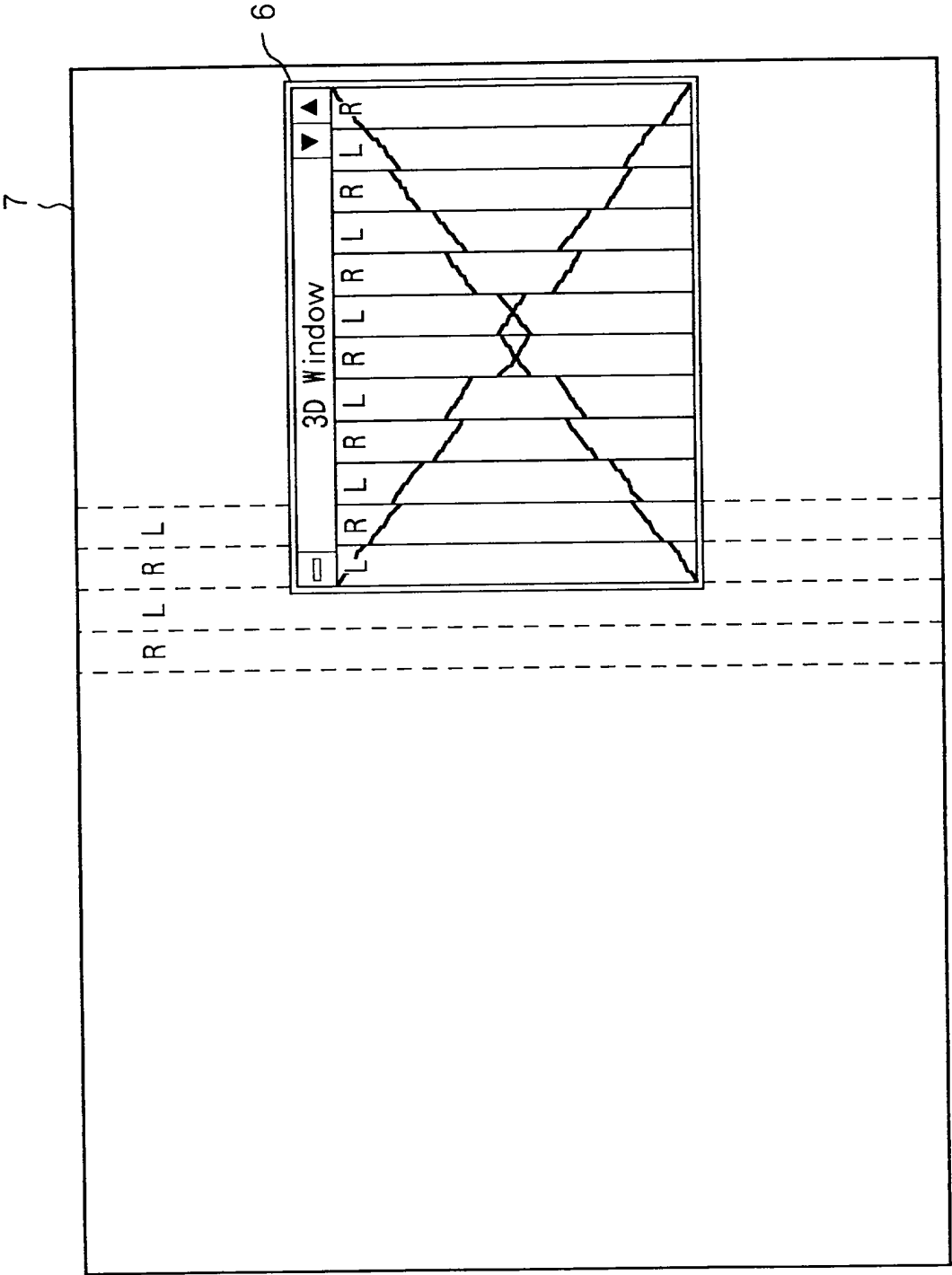


FIG.8

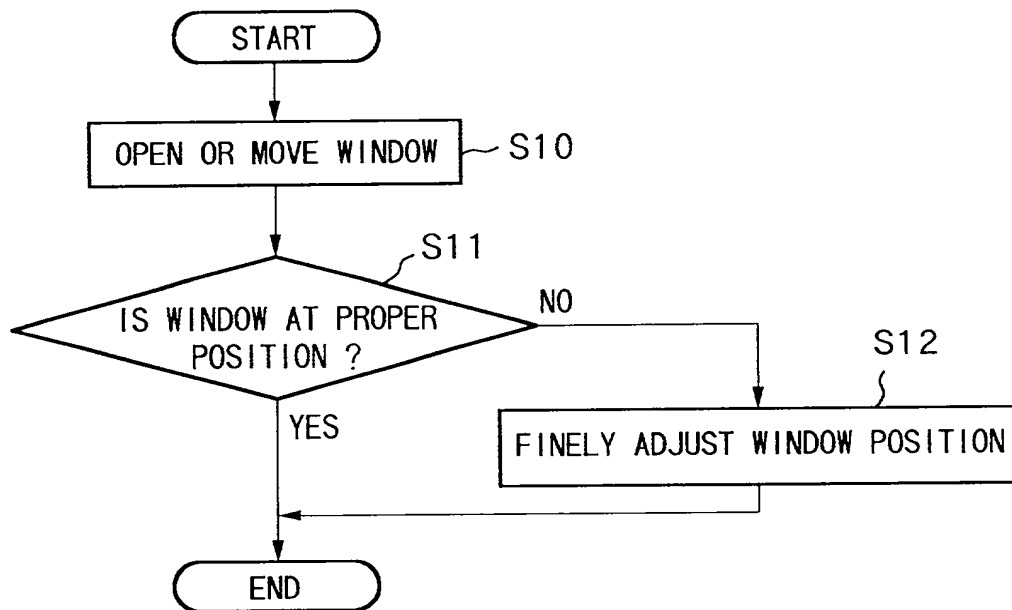


FIG.9

※ DASHED LINES INDICATE POSITION OF WINDOW AFTER MOVEMENT

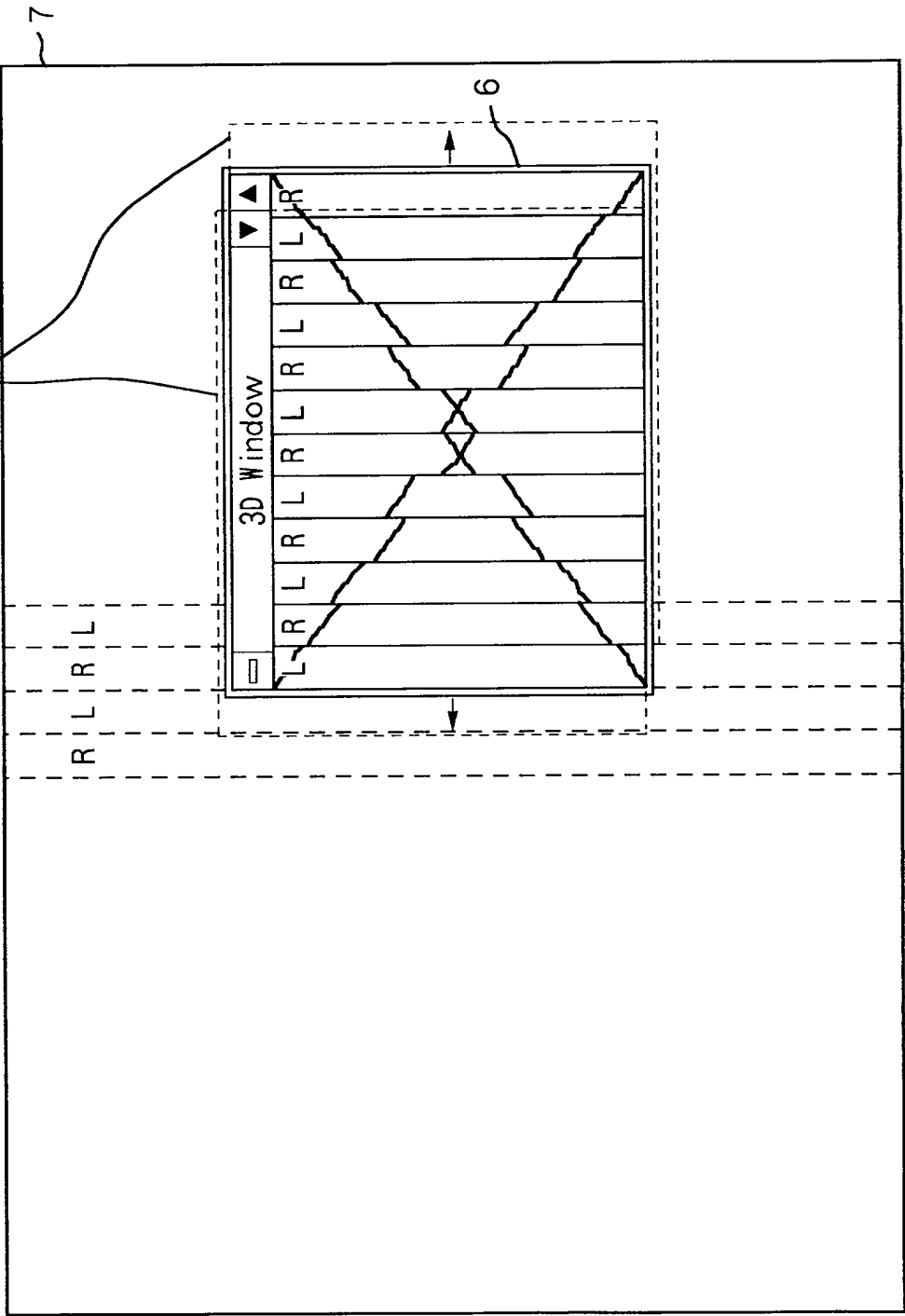


FIG.10

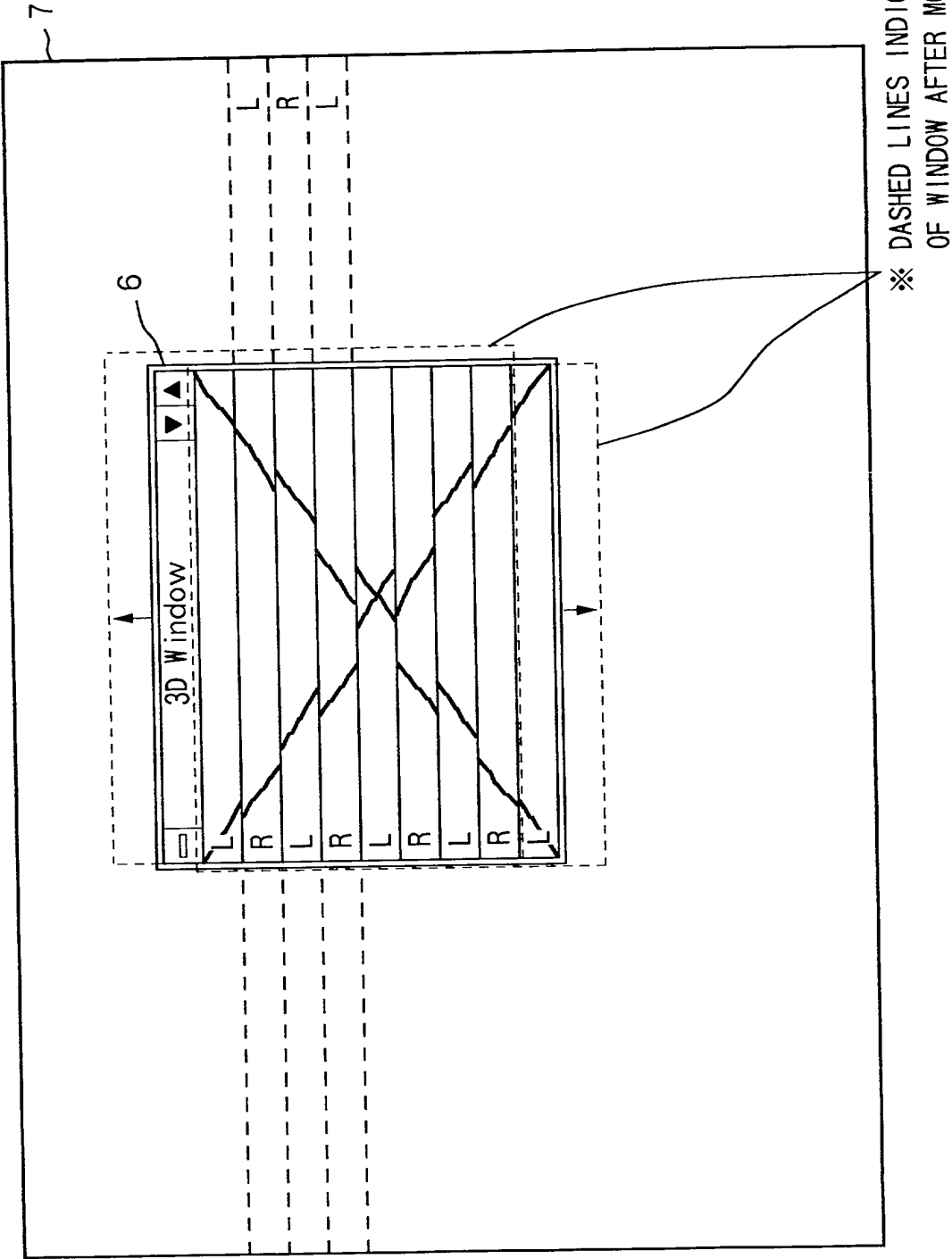


FIG.11

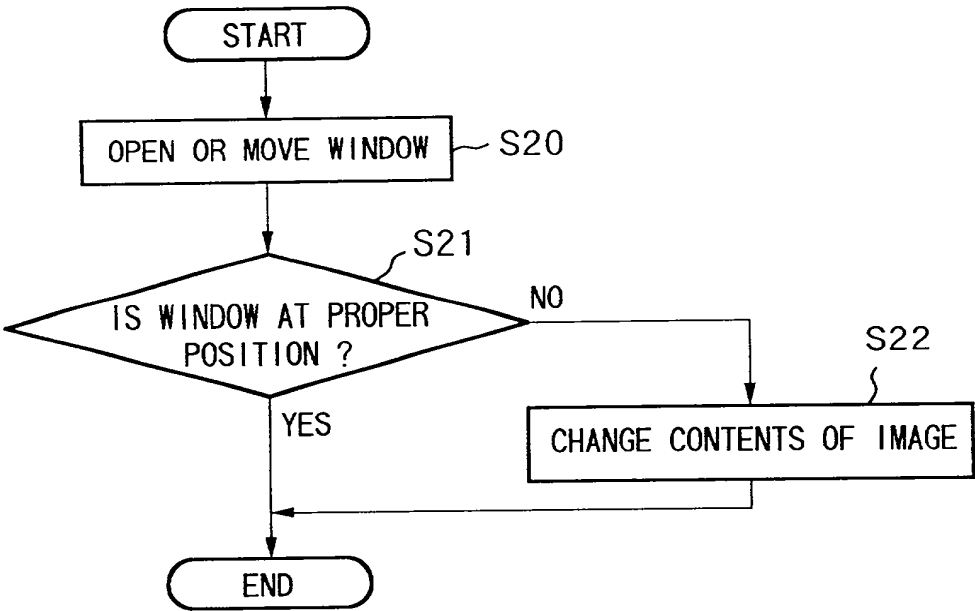


FIG.12

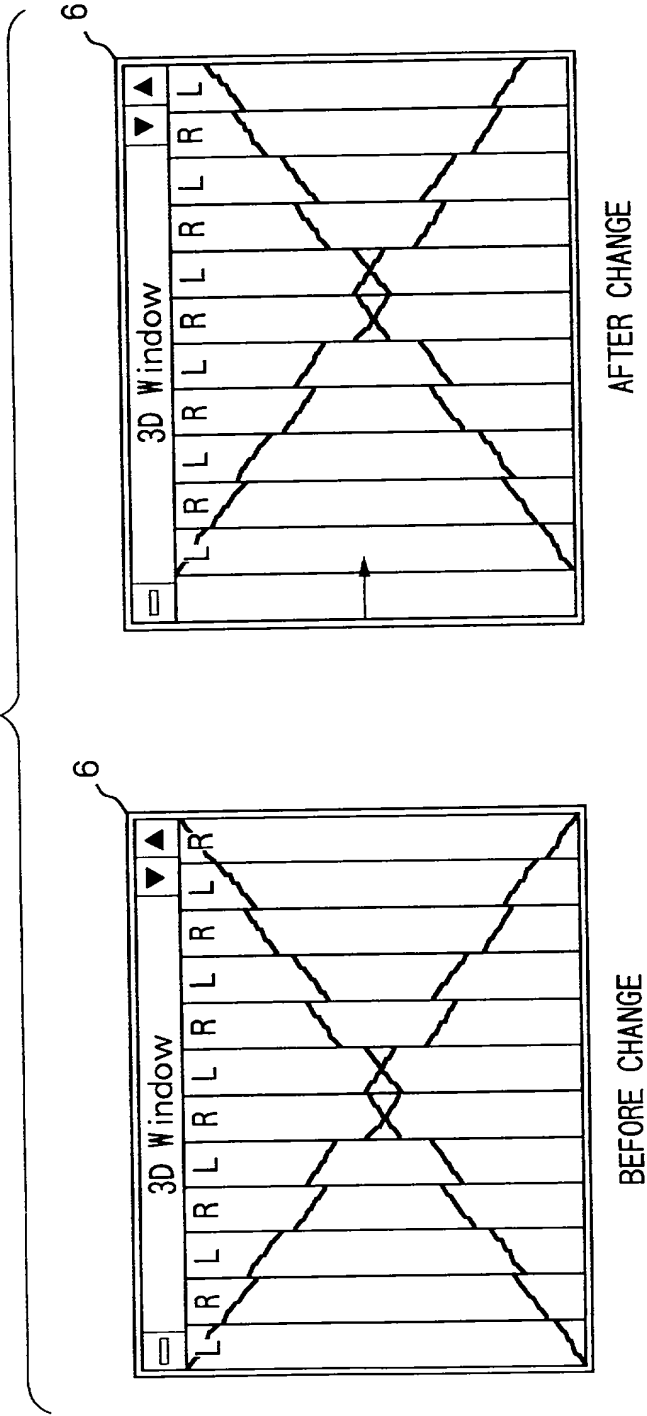


FIG.13

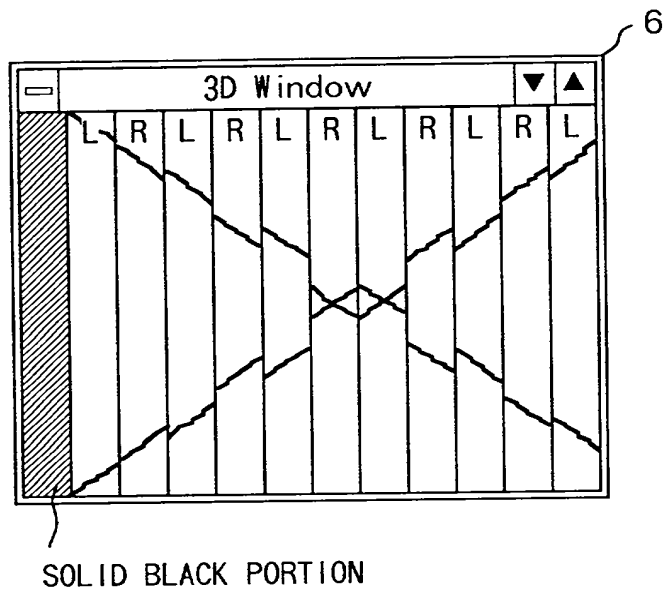
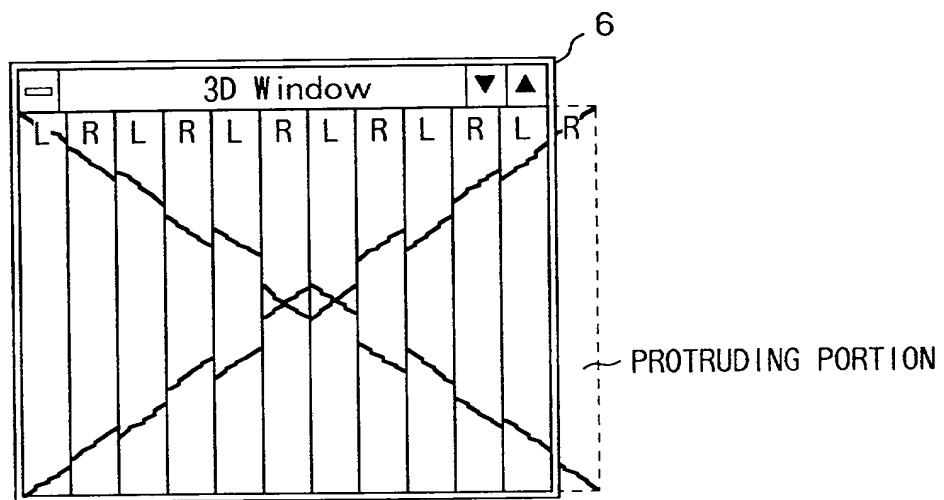
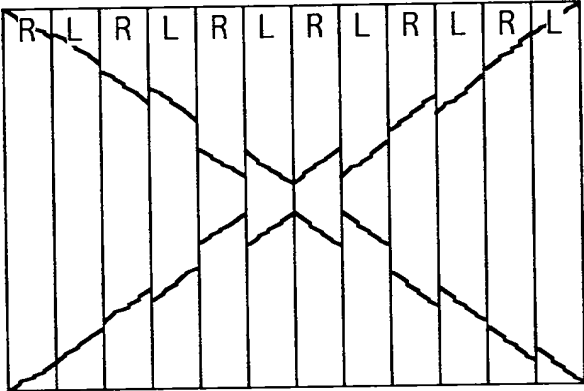


FIG.14



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FIG.15



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FIG.16

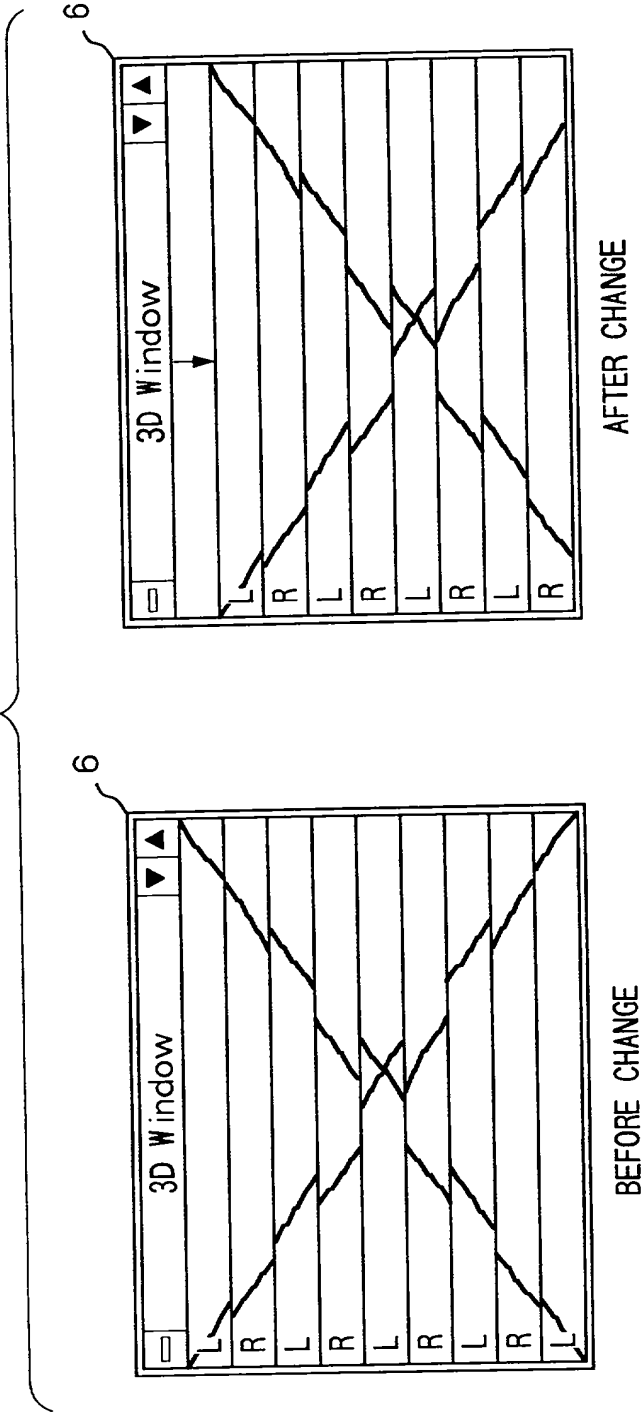


FIG.17

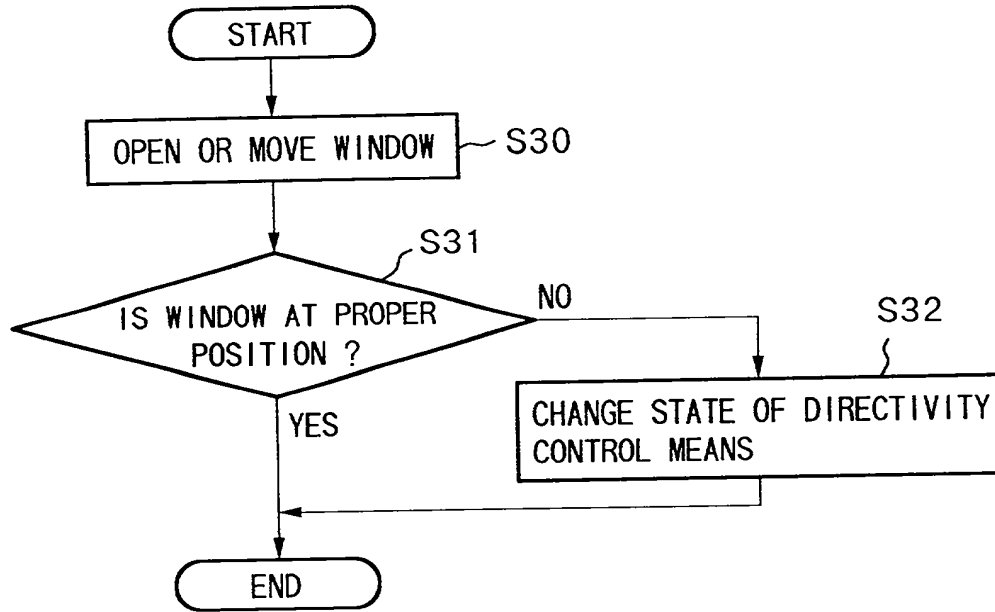


FIG.18

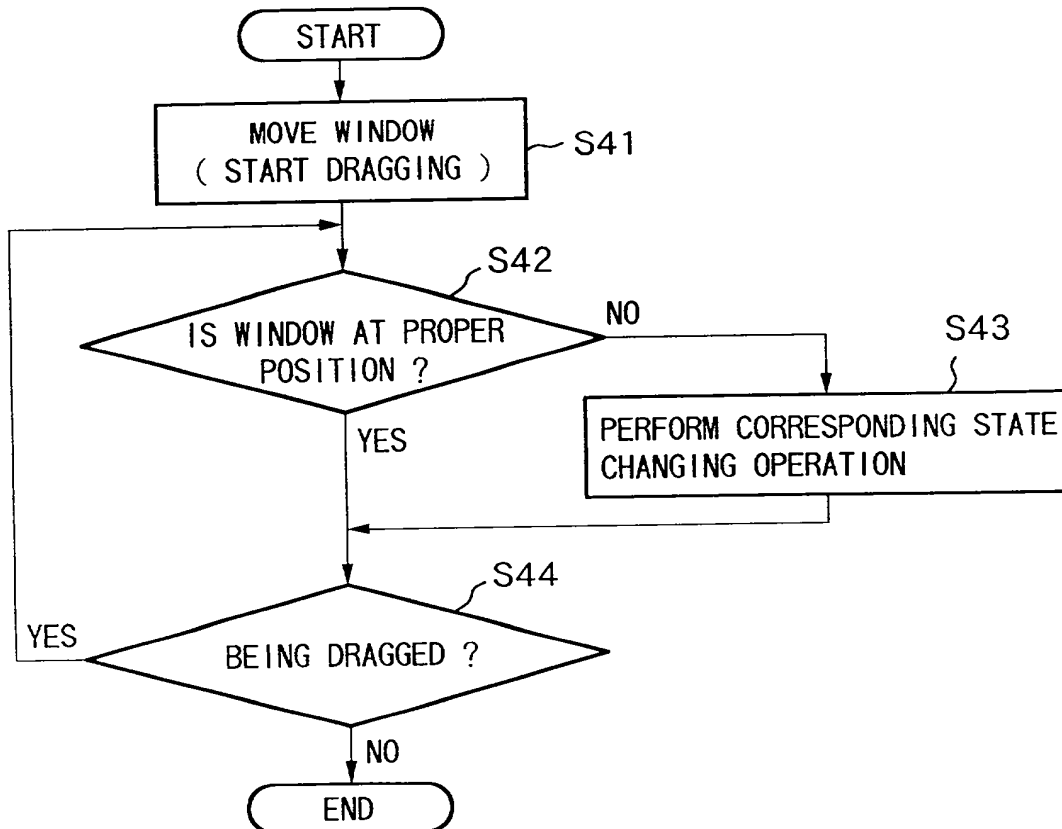
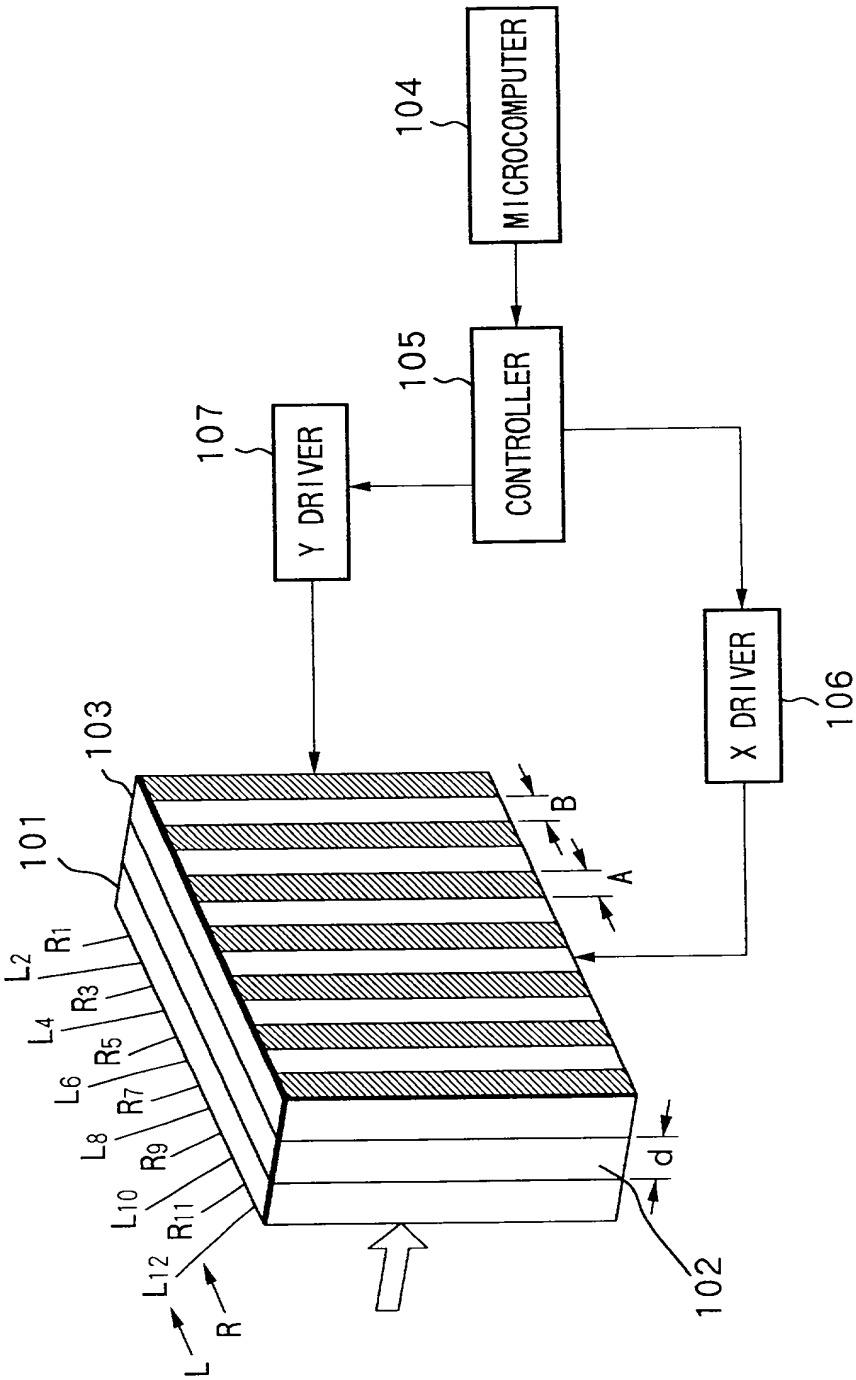


FIG.19



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FIG.20A

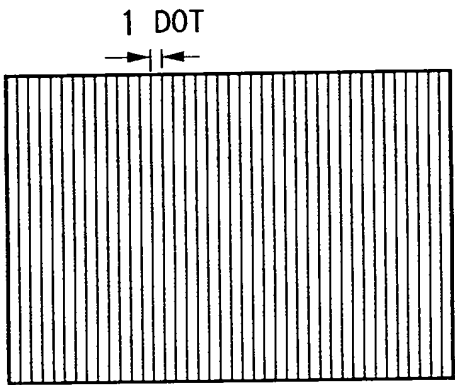
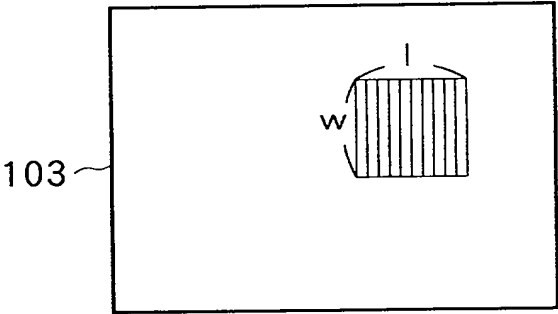


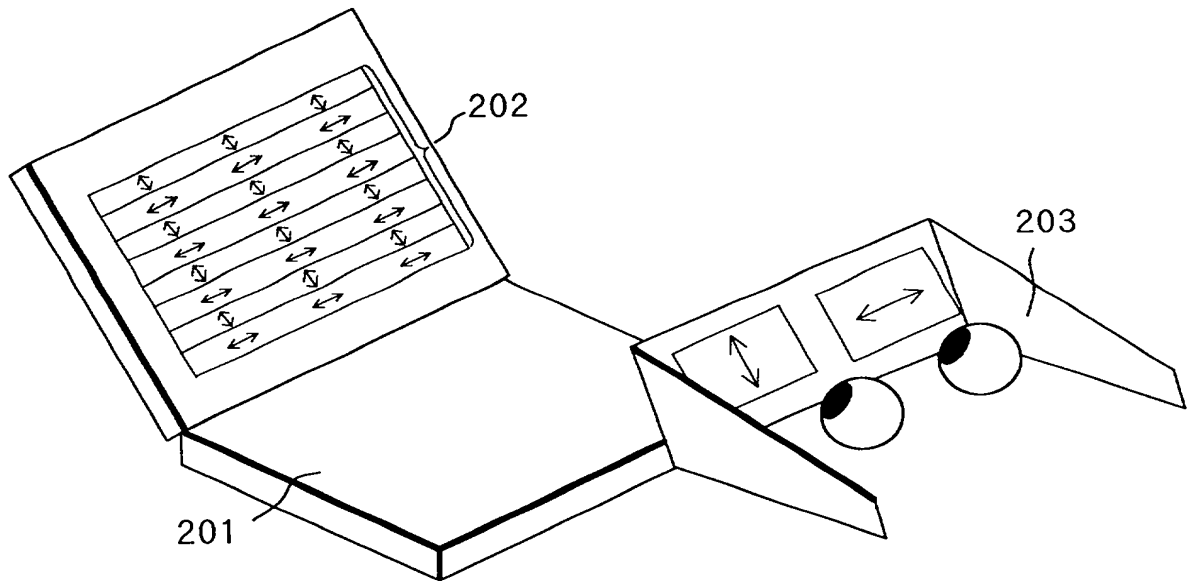
FIG.20B



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FIG.21



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FIG.22

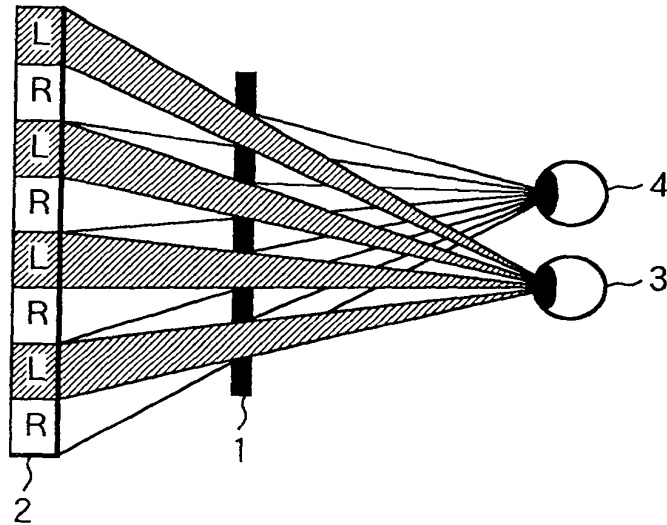


FIG.23

